



PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. VI, No. 1, pp. 1-17, pl. 1.

MAY 6, 1916

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EOCENE OF LOWER COWLITZ RIVER VALLEY,
WASHINGTON

BY

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INTRODUCTION

The purpose of this paper is to place upon record the results of geologic and faunal studies made by the writer during the past three years in portions of the lower Cowlitz River Valley. The area under investigation is of special interest because of the large number of exposures of Eocene strata and the exceptionally well preserved faunas contained within them.

Surface outcrops of Tertiary formations in western Washington are largely obscured because of the heavy overburden of Pleistocene deposits. In King and Pierce counties much detailed work has been done so that the lithology and structure of the Eocene rocks is fairly well known.¹ The strata in this region are, however, almost entirely of estuarine origin, rendering it impossible to make satisfactory correlations with the Eocene of other parts of the Pacific Coast. Isolated outliers of Eocene rocks occur in many localities such as Crescent Bay

¹Willis, Bailey, and Smith, Geo. O., Tacoma Folio, U. S. Geol. Surv. 1899.

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along the Strait of Juan de Fuca, the low hills about Tenino and Centralia in Chehalis County and the exposures on Coal Creek north of Columbia River in Cowlitz County. At these localities only fragmentary sections of the Eocene column of Washington can be studied. The region under discussion in this paper contains the most complete fossiliferous marine section occurring within the western portion of the state.

REVIEW OF LITERATURE

One of the earliest important scientific references to the geologic conditions in this region is to be found in the report by Dr. Ralph Arnold² on "The Tertiary and Quaternary Pectens of California." He described *Pecten landesi* from this area. The following quotation is well worth noting: "*P. landesi* is found quite abundantly in a dark greenish sandstone bed that outcrops about 100 yards west of the junction of Stillwater and Olequah creeks (U. S. Nat. Mus. locality 4019) one-fourth mile southwest of Little Falls, Lewis County, Wash. It is also found in a similar matrix in the bed of Olequah Creek (U. S. Nat. Mus. locality 4024), one mile north of the first locality. It is associated in this formation with a characteristic Eocene fauna, among which are the following species: *Venericardia planicosta* Lamarck, *Thracia dilleri* Dall, *Crassatellites* sp., *Meretrix* sp., *Ostrea* sp., *Pteria* (cf.) *limula* Conrad, *Cardium* 2 sp., *Barbatia* sp., *Glycimeris* sp., *Corbula* sp., *Callista* sp., *Turritella* (cf.) *uvasana* Conrad, *Fusus* 4 sp., *Ocenebra* sp., *Ranella* sp., *Calyptrophorus* sp., *Lunatia* sp., *Turbinella* (?) sp., *Murex* 2 sp., *Conus* sp., *Cassis* sp., *Tritonium* sp., *Dentalium* (cf.) *cooperi* Gabb, and *Nautilus* sp. This horizon is probably upper Eocene, possibly above the Tejon." Dr. Arnold's suggestion that this horizon is very high in the Eocene seems to be well in accord with more recent studies.

The Geology and Paleontology of this area is discussed in a paper by the writer³ published in 1912. A large fauna was noted as occurring along the banks of Cowlitz River about one

²Arnold, Ralph, The Tertiary and Quaternary Pectens of California. Professional Paper 47, U. S. Geol. Surv., p. 52, 1906.

³Weaver, C. E., "A Preliminary Report on the Tertiary Palaeontology of Western Washington," Bull. 15, Wash. Geol. Surv., pp. 12-15, 1912.

and one-half miles east of the town of Vader in Lewis County. Many new species of mollusks were described and the fauna as a whole was referred to the Cowlitz formation which was regarded as of Eocene age and possibly older than the Tejon. A suggestion was, however, made that future studies might show that it was identical with the Tejon.

A further discussion of this region is to be found in a report by Arnold and Hannibal⁴ on "The Marine Tertiary Stratigraphy of the North Pacific Coast of America." In this paper the Tejon is divided into three formations: the Chehalis, Olequah and Arago formations. They are referred to as the Tejon Series. The Chehalis and Olequah formations are present in the region involved in this report. The Arago is absent. On the basis of fossil floras colder climatic conditions obtained during the deposition of the Chehalis formation than during that of the Olequah.

During the last year an important paper appeared by Dr. Roy E. Dickerson⁵ entitled the "Fauna of the Type Tejon: Its Relation to the Cowlitz Phase of the Tejon Group of Washington." Collections were made and studied from certain localities along the Cowlitz River and a number of new species were described. A total of 95 species are listed from Washington and 55 of these are found within the Tejon of California. The paper gives the results of studies at the type Tejon locality in southern California and makes correlations with the Cowlitz phase of the Tejon in Washington. He states "The Cowlitz phase of the Tejon of Washington appears to represent the same faunal facies as the fauna of the type Tejon, i. e., the *Rimella simplex* zone is present in both localities."

GEOGRAPHY OF AREA UNDER INVESTIGATION

The region involved in this study is situated in southern Lewis County and extends from the town of Winlock southerly for a distance of fifteen miles to the town of Castle Rock. From east to west the area averages five miles in width. Just east

⁴Arnold, Ralph, and Hannibal, Harold, *The Marine Tertiary Stratigraphy of the North Pacific Coast of America*, Proc. Am. Phil. Soc., vol. 52, pp. 566-571, 1913.

⁵Dickerson, R. E., "Fauna of the Type Tejon: Its Relation to the Cowlitz Phase of the Tejon Group of Washington," Cal. Acad. Sci. Proc., 4th series, vol. 5, pp. 35-51, 1915.

of the town of Vader (formerly known as Little Falls and Sopenah) the Cowlitz River swings from its east-west course and assumes a due north-south direction. One mile south of Vader, Stillwater Creek enters Cowlitz River and about one-fourth mile south of the town, Olequah Creek joins Stillwater Creek. From this point Olequah Creek extends almost due north to Winlock. The Northern Pacific Railway between Portland and Seattle follows the valley of this creek.

The drainage of the entire area is southerly to the Columbia and the hills on either side rise gradually into a rolling timbered country. Eocene strata away from the banks of the creeks are not exposed but are covered with gravels and sands formerly deposited by Cowlitz River.

STRATIGRAPHY

In the examination of this region a transit survey was made of Stillwater and Olequah creeks and the position of all fossil localities as well as observations taken upon strikes and dips definitely located. These data have been plotted upon the map accompanying this report.

Between the towns of Castle Rock and Olequah only four exposures of Eocene strata are known to occur. They consist of dark gray, sandy shales with intercalated basaltic flows. Two miles north of Castle Rock and 2,000 feet south of the Northern Pacific Railway bridge over Toutle River, there is an exposure in the railway cut composed of bedded tuffaceous materials together with sedimentary deposits of worked over basalt. These beds have a strike of N. 75° E. and a dip of 5° N. W. They are overlaid with Pleistocene deposits composed of sand and gravel intermixed with angular fragments of basalt, which appear to have been derived by rapid erosion from nearby bluffs of Eocene basalt.

From this point northerly for a distance of two miles the only exposures along the railway consist of Pleistocene gravels and sands. One and two-thirds miles north of the Toutle River bridge Eocene rock outcrops occur for a distance of 450 feet. The bluffs at this point are about 60 feet high and con-

sist of thinly bedded, fine-grained, dark brown shale containing a few narrow bands of sandstone. The total thickness of the sediments at this point is about 75 feet. They are overlaid with 35 feet of black basalt showing well defined columnar jointing. Both the sedimentaries and lavas have a strike of N. 80° E. and a dip of 10° to the N. W.

About one-half mile south of the railway bridge across Cowlitz River there is a third exposure of Eocene basalt but no sedimentary rocks. The lower portion of the bluff is made up of agglomeratic materials consisting of a heterogeneous mass of angular fragments of badly weathered, dense and vesicular basalt having a thickness of 20 feet. Above this is a flow of fine grained, dense, black basalt exhibiting a tendency to columnar structure. The approximate strike of these flows is nearly east and west with a low dip to the north. The eroded surface of this outcrop is overlaid with Pleistocene sands and gravels.

One-half mile north of the previously mentioned outcrop, and along the south bank of Cowlitz River at the railway bridge, basalts and sedimentary rocks again appear. At the south end of the bridge and along the river there is a quarry composed of basalt exhibiting pronounced columnar structure. Lying conformably below the basalts are dark shales and brown sandstones, which in places contain narrow carbonaceous bands. They are about 60 feet in thickness with a strike of N. 35° W. and a dip of 10° to the N. E. From this point northward to the town of Olequah no recognizable exposures of the Eocene occur.

At one of the above mentioned localities a single specimen of *Turritella uvasana* Conrad was collected, but aside from this, the only fossils occurring are a few plant fragments and wood. From observations taken upon strike and dip there appears to be a continuous low dipping series of sedimentary beds with intercalated basaltic flows extending from Castle Rock to Olequah. However, it is possible that there may be folding and faulting in the intervening covered areas. If the strata are continuously dipping northward they possess a thickness of at least 6000 feet. From Olequah northward to Winlock, where the strata are better exposed, a stratigraphic sec-

tion can be made. The sediments in the area between Castle Rock and Olequah are stratigraphically below those outcropping between Olequah and Winlock.

Section between Olequah and Winlock:—Strata of Eocene age outcrop in the banks of Olequah and Stillwater creeks and also along the railway track at many places between Olequah and Winlock. They consist predominately of massive, sandy, clay shales together with grayish brown sandstones containing carbonaceous seams. These materials are of marine, brackish and fresh water origin. With the exception of the basal portion of this section, basaltic flows are absent. The basal part involves certain sandstones and basalts outcropping at the town of Olequah. The upper portion of the section is two miles south of the town of Winlock. The actual contact of the upper limit of the Tejon and the overlying Oligocene has not been definitely determined. Four hundred feet south of the last Oligocene outcrop in the banks of Olequah Creek are Eocene shales containing a marine Tejon fauna. It is impossible to say whether the two formations are conformable or not. The strata have approximately the same strike, but the dip of the Oligocene is only 2° to the northeast, while that of the Tejon is 27° in the same direction. It is possible that the two formations are conformable but that in the interval of 400 feet between them the dip flattens out.

The lower portion of this section as exposed along Stillwater Creek to the southwest of Vader and as far south as Olequah is of marine origin. Stratigraphically above, these strata grade into those of brackish water origin and finally into those containing a freshwater fauna. Still higher up in the section they pass back to a brackish water condition and finally to marine. The entire upper portion of the section is a marine deposit. The total thickness of the Eocene section, as measured from Olequah to Winlock, is approximately 4970 feet.

The following stratigraphic section shows approximately the variations in the lithologic character of the sediments from the base to the top, including a part of the overlying Oligocene.

TOP OF SECTION	Feet
Banded sandstone and shale as exposed at the town of Winlock and in the banks of Olequah Creek to the west and northwest of town. The fauna occurring at Locality No. 229 is characteristic of this zone.....	500
Massive clay shale grading in places into sandy shale as exposed along the banks of Olequah Creek south of Winlock and also in the bank of Cowlitz River in Section 5, Township 11 North, Range 2 West, at fossil Locality No. 239 (locally known as the Graeco Ranch). This is the base of the Oligocene in this region	600
Top of Eocene section. Chiefly sandy shale grading into massive clay shale of a dark brownish gray color. Exposures representing this phase are not very abundant but contain occasional specimens of <i>Venericardia planicosta</i> Lamarck and <i>Turritella uvasana</i> Conrad	960
Shaly sandstone	100
Slightly banded sandy shale.....	130
Slightly carbonaceous sandy shale.....	50
Sandy shale	430
Laminated sandstone and sandy shale.....	150
Shale, slightly sandy. The upper part of this zone contains an abundant marine Tejon fauna.....	340
Massive clay shale containing the fauna at Localities Nos. 1, 1a, 232 and 233, in the north bank of Cowlitz River, Section 25, Township 11 North, Range 2 West.....	50
Sandy clay shale. This is the base of the upper marine division of the section	70
Brackish water zone. Yellowish brown sandstone with interbedded lignitic layers. These sandstones often grade into carbonaceous sandy shales.....	520
Freshwater zone. Light gray massive clay shale, containing numerous freshwater Eocene invertebrates. Fossil Localities Nos. 295 and 303 occur in these shales.....	130
Lower brackish water zone. Sandy shales and shaly sandstones often grading into brownish yellow coarse grained sandstones. All are more or less carbonaceous. Fossil Localities Nos. 231, 234 and 300 occur within this zone.....	550
Lower marine zone. Sandy clay shales grading into shaly sandstones. Fossil Localities Nos. 240, 240b, 299, 241, 238, 301, 236, 298, 294 and 294a occur within this zone. The basal portion of this belt contains a few very narrow layers of brackish water sediments. Below this belt no detailed measurements of the strata have been made. The underlying strata are those involved in the area between Castle Rock and Olequah. Just below the base of these marine beds, flows of basalt and deposits of basaltic tuff are intercalated with the sediments, which appear to be predominatingly of brackish water origin..	390
Total thickness of measured strata between Olequah and Winlock	4,970
Possible thickness of unmeasured strata involved in area between Castle Rock and Olequah.....	6,000
Possible total thickness of Eocene as exposed in the lower Cowlitz Valley section	10,970

STRUCTURE

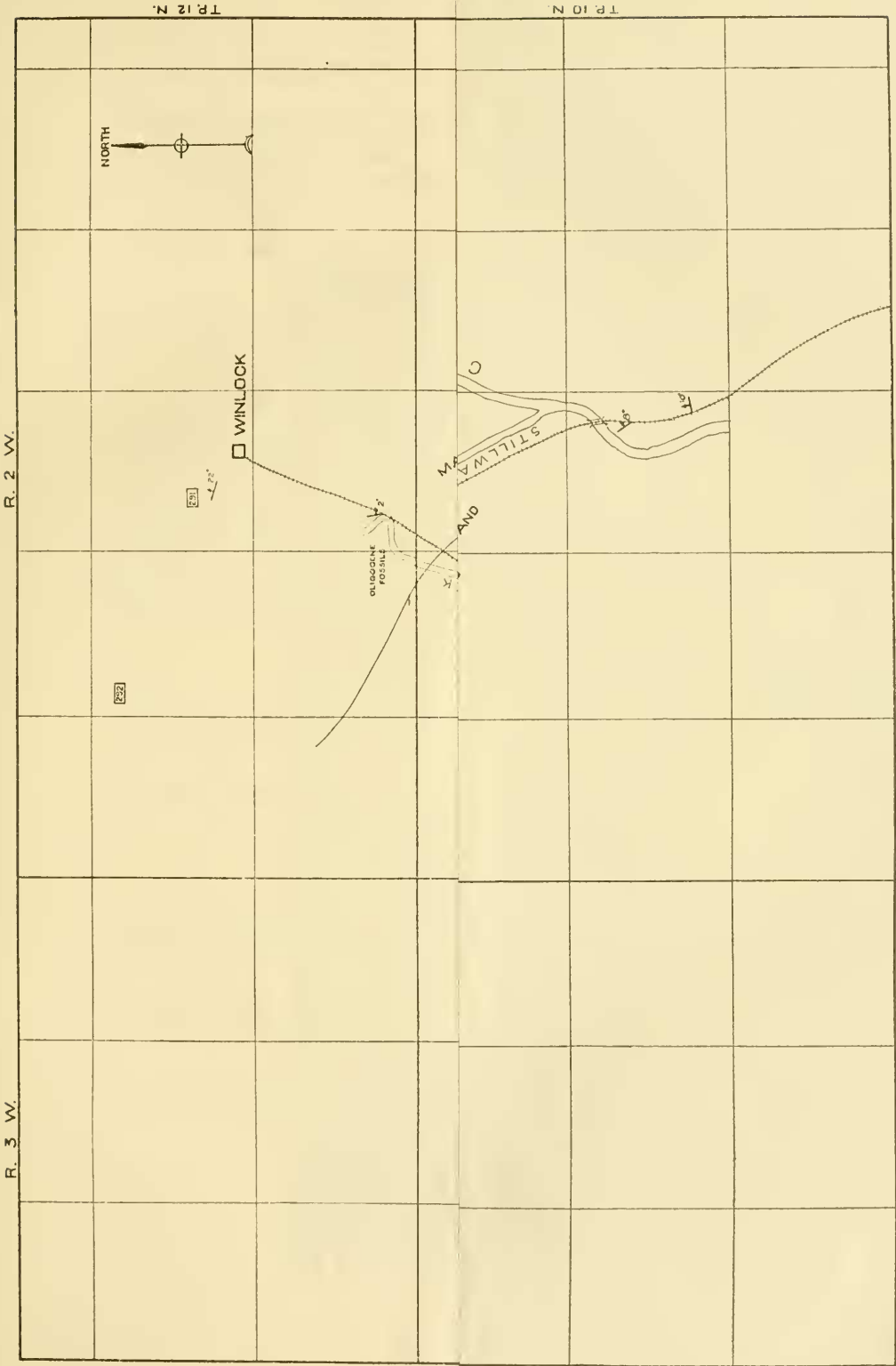
The entire series of Oligocene and Eocene deposits involved in this region exists in the form of a northeasterly low dipping monocline. It is probably the southwestern limb of a broad syncline, the northeastern limb of which occurs in the region around Chehalis and Centralia. There are minor undulations in the northeasterly pitch of the strata between Olequah and Winlock. In the vicinity of Vader a low, shallow anticline has been developed whose axis trends N. 30° W. It crosses Olequah Creek one-half mile north of Vader. The strata on the north side of this minor fold dip to the northeast at an angle of 40° and on the southwest side at an angle of 15°. One thousand feet south of the axis of the minor anticline there is a shallow syncline having approximately the same trend as the anticline. At the point where the axis of the anticline crosses Olequah Creek the same marine strata are brought to the surface which occur to the southwest of Vader along Stillwater Creek above its junction with Olequah Creek.

A glance at the map accompanying the report indicates several apparent discordances in strike and dip in the vicinity of Olequah. It might be inferred that the strata had been greatly disturbed and faulted. However, such is not the case. There are simply minor undulations in strike and dip along the prevailing direction of strike. The variations as shown upon the map were inserted for the purpose of emphasizing these irregularities.

FAUNAL RELATIONS

In constructing the stratigraphic section accompanying this paper an attempt was made to arrange the fossil localities in their stratigraphic sequence. The following localities range from the base near Olequah to the upper portion of the section near Winlock: Localities Nos. 299, 5, 236, 298, 294, 294a, 241, 238, 301, 231, 234, 300, 295, 1, 1a, 232, 233, 239, 292 and 229.

Localities 299 to 301 contain a marine fauna. Localities 231 to 300 contain a brackish water fauna. Localities 295 and 303 contain a freshwater fauna. Localities Nos. 1 to 233





Sketch Map showing structural conditions along Cowlitz River between Olequah and Winlock.

contain a marine fauna. Localities Nos. 239 to 229 have a marine Oligocene fauna.

A description of the locations of the several fossil localities is here inserted.

- Locality No. 299—From an embankment along the Northern Pacific Railroad, 2850 feet south of milepost 76 and three-fourths of a mile north of Olequah Station, in Section 32, Township 11 North, Range 3 West.
- Locality No. 5—From a fossil ledge at the junction of Olequah and Stillwater creeks, in Section 32, Township 11 North, Range 3 West.
- Locality No. 236—On Stillwater Creek, Lewis County, 2200 feet above its junction with Olequah Creek, in Section 30, Township 11 North, Range 2 West.
- Locality No. 298—About 100 feet west of Locality No. 236.
- Locality No. 294—In the bank of Stillwater Creek about one and one-third miles below its junction with Olequah Creek in Section 30, Township 11 North, Range 2 West.
- Locality No. 294a—An earlier collection made at same Locality as No. 294.
- Locality No. 241—In the bank of Stillwater Creek about one and two-fifths miles below its junction with Olequah Creek, in Section 30, Township 11 North, Range 2 West.
- Locality No. 238—On Olequah Creek three-fourths of a mile north of Vader Station in the east bank of the creek just north of a point where a small creek enters Olequah Creek from the east. In Section 29, Township 11 North, Range 2 West.
- Locality No. 301—From the banks of Olequah Creek one-half mile north of Vader and south of the four-foot falls in the creek. The strata vary from a shaly sandstone to a sandy shale.
- Locality No. 231—Fossil Locality No. 234 should also be considered with No. 231, as they are both from the same locality, but from two separate ledges only eight feet apart. From Olequah Creek about three-fourths of a mile north of Vader, just south of the big bend in the creek. A small band of fossils. In Section 28, Township 11 North, Range 2 West.
- Locality No. 234—A narrow band in Olequah Creek about three-fourths of a mile north of Vader, just south of big bend in creek. About eight feet stratigraphically above Locality No. 231.
- Locality No. 300—On Olequah Creek one-fourth mile above Vader Station, in east bank of creek just north of point where small creek enters from east. In Section 29, Township 11 North, Range 2 West.
- Locality No. 295—Located about one and one-half miles north of Vader, in the bend in Olequah Creek at the point where the creek lies close to the Northern Pacific Railway track at milepost No. 73. The fauna is entirely of freshwater origin and is in a belt of gray shale.
- Locality No. 1—Located about one and one-half miles east of Vader, on the west bank of Cowlitz River, in massive sandy shales of marine origin, situated in Section 27, Township 11 North, Range 2 West.

- Locality No. 1a—A zone at the base of the section as represented at Locality No. 1.
- Locality Nos. 232 and 233—A second collection made at Locality No. 1 and kept separate from No. 1.
- Locality No. 239—Located in the N.E. $\frac{1}{4}$ of Section 25, Township 11 North, Range 2 West, on the east side of Cowlitz River three-fourths of a mile above the ferry on Mr. Greece's ranch. The fauna is Oligocene and is the equivalent of the faunas occurring south of Winlock in Olequah Creek at Localities Nos. 292 and 229.
- Locality No. 292—Oligocene, one mile south of Winlock in bank of Olequah Creek.
- Locality No. 240—An Eocene locality south of Vader in the banks of Stillwater Creek at a dam near the lumber mill. The locality is just east of the Northern Pacific Railway bridge over the creek. The strata are sandy shales and sandstones dipping at low angles to the north-east. Immediately above these strata brackish water species appear.

FAUNAL LISTS—(Cont.)

[illegible]